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Overview Hydrologic Assessment of Juliet Creek Watershed

By

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January 2002

Overview Hydrologic Assessment

of

Juliet Creek

(Merritt Forest District)

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EXECUTIVE SUMMARY

Based on the office work and field surveys, the following conclusions are presented for peak flows, sediment sources, and riparian and channel stability in the Juliet Creek watershed.

In general, there has been a low amount of forest development in the Juliet Creek watershed. Both current and proposed ECA's in sub-basins and over the total watershed are less than 13%, which does not represent a hydrologic concern for an increase in peak flows over natural levels.

Forestry-related mass wasting was not observed in the field surveys, although slides, torrents and debris flows are natural processes on the steep slopes draining to the valleys. Two road systems are recommended for deactivation (or upgrading) due to a number of sediment sources at crossings and potential impacts to roads from debris flows in steep tributaries. These are: the access route to 156-1 in the residual area and the south road in the July Creek sub-basin. Three sediment sources (SS4, SS5 and SS11) can be addressed by deactivating or replacing culverts. Other roads were stable or set back sufficiently from streams and therefore pose a low concern for sediment delivery.

There has been a low amount of riparian harvesting around mainstem channels. No impacts to Juliet Creek were noted at the single case of riparian harvesting around the mainstem, located in the North sub-basin. Logging has occurred along small tributary creeks (<1.0-3.0m Wb) but, in general, no stability concerns were observed. An exception is channel disturbance for approximately 50-75m (bank erosion and trees felled/windthrown into creek) associated with riparian logging (opening 6, polygon 669) at Tributary 4.

Streams are active, aggraded and laterally unstable, particularly in the valleys of Juliet Creek and sub-basins. Mainstem channels are charged with sediment with potential to migrate downstream at annual freshets. Instability is natural, and related to high stream power at floods. Instability was also observed at steep tributaries (torrents and debris flows). Forestry activities have had a low impact to channel conditions, however, except for localized sedimentation effects at road crossings as discussed above.

Proposed forest development is a low concern for increasing peak flows in the watershed. However, there are hydrologic concerns related to the location of some of the blocks over steep terrain, or above existing sediment problems, and the potential to initiate or accelerate debris flow or torrents. Recommendations are provided in the following section to address existing and potential hydrologic concerns.

RECOMMENDATIONS

To protect the water quality in the Juliet Creek watershed, it is recommended to:

1. Stabilize sediment sources SS1, 2 and 3 prior to road building or harvesting on the north slope of the residual area. This can be done by deactivating or upgrading the access route to proposed 156-1.

2. Move the south border of A56181 away from the creek, and stabilize SS7 to SS10 prior to harvesting. Should development not proceed, or following the completion of harvest, deactivate the south road system in the July Creek sub-basin due to sediment delivery potential to streams from an eroding road surface and ditchline, and to mitigate road wash-out potential from torrents at tributaries.

3. Install or replace culverts at SS5 and SS4 and stabilize SS6 prior to harvesting upslope blocks 156-2 and 3.

4. Assess the potential for harvesting in the south portion of Block 106-6 to initiate a landslide by a terrain specialist.

5. To mitigate debris flow potential at steep tributaries, ensure that logging debris at the proposed blocks does not enter channels and natural drainages are maintained at roads to 106- 5 & 6, 156- 5, 6, & 7. Set borders back to the top of the outer gorge, where applicable, to avoid harvest on channel sidewalls.

6. Use temporary crossings to 106-6 at Tributary 1 and to 156-6 at Tributary 4 because of proximity to steep channel terrain, and deactivate these crossings immediately after harvesting.

7. Deactivate all proposed roads after harvesting.

8. Remove/replace the collapsed crossing at SS11 in July Creek sub-basin.

9. Periodically monitor the performance of the in-stream works at MW1 after the annual flood.

Overview Hydrologic Assessment

of

JULIET CREEK

1.0 INTRODUCTION

This report presents the results of an overview hydrologic assessment of the Juliet Creek watershed, located approximately 45km south-west of Merritt within the Merritt Forest District.

The main purpose of the report is to assess the cumulative hydrologic impact of historical and proposed forest harvesting in the watershed.

2.0 DESCRIPTION

Juliet Creek watershed is somewhat oval in shape and drains an area of 8,916 ha. The mainstem meanders west to east from steeply sloped headwaters at sub-basins to a broad valley flat near the mouth at the Coldwater River (1010m elevation). The watershed is the largest tributary to the Coldwater River. The highest point in the watershed is July Mountain at an elevation of 2134m. July Creek is a major tributary to Juliet Creek, and comprises 2090 ha or 23% of the total watershed area.

The Juliet Creek watershed is located at the western edge of the Cascade Mountains physiographic unit as classified by Holland (1976). Bedrock is a mix of folded and metamorphosed sedimentary and volcanic rocks with intrusions of granitic batholiths. There are sharp peaks and ridges in the watershed, and valleys show the effects of alpine glaciation.

Juliet Creek is not a community watershed and there are no water licenses. The mainstem of Juliet Creek is known fish bearing (bull trout) up to 1400m elevation in the North and South sub-basins and 1560m in the July Creek sub-basin. Rainbow trout and bull trout have been inventoried in the lower reaches of Juliet Creek (Nicola Tribal Association, personal communication), (Beniston and Lister 1992). Chinook and coho salmon and steelhead trout were captured in Juliet Creek in 1987 (G. Naito, personal communication). A fish barrier is reported at the lower reaches of July Creek (Nicola Tribal Association 1998).

Forest harvesting dates back to the late 1970's with the majority occurring in the mid 1980's. Historical harvesting has primarily been near to the valley bottoms along the mainstem and tributaries. Cattle grazing is also an identified activity in the watershed. Private land is located near the confluence of July and Juliet Creeks and consists of approximately 10 ha or less than 1% of the total watershed area. There are a number of mine claims located primarily south of the Juliet mainstem in the residual area and at the

confluence of the north and south tributaries of the July Creek sub-basin (http://ebony.gov.bc.ca/mapplace/minpot/mtitles2htm.cfm).

Linear developments such as the construction of the Coquihalla highway, and gas pipeline have resulted in substantial channel modifications near the mouth. Juliet Creek has been straightened and banks rip-rapped in the lower 700 - 800m. Compensatory structures (e.g. off-channel) for lost fish habitat have also been installed (Beniston and Lister 1992). Due to these anthropogenic influences to the lower portion of Juliet Creek, the point of interest (POI) for assessment purposes is located above the Coquihalla highway, just below the confluence with July Creek.

Maximum 2000 (7-day max) stream temperature in Juliet Creek ranged from 12.7°C to 17.3°C and in July Creek from 12.0°C to 15.2°C (Henderson 2001). In 2001, maximum temperatures ranged from 13.3°C to 19.2°C in Juliet Creek and 11.6°C to 15.4°C in July Creek

3.0 SUB-BASINS

Juliet Creek at the POI is 4th order (map scale 1:20,000). For forest development planning purposes, the hydrological assessment for the Juliet Creek watershed has been divided into three 3rd order sub-basins: South, North and July. A residual area that drains to the lower elevations of the mainstem is included as part of the total watershed (see map).

South sub-basin, with a total area of 1502 ha, is situated in the southwest portion of watershed. The sub-basin drains north from a height of 2134m to the confluence with North sub-basin and the residual area of the Juliet Creek (1190m).

North sub-basin has an area of 2596 ha and drains east from an elevation of 2040m to the mainstem of Juliet Creek at 1190m.

July Creek sub-basin is 2090 ha and is located south of the residual area. The sub-basin drains northeast from July Mountain (2134m) to the confluence with Juliet Creek at 1030m.

4.0 PROPOSED DEVELOPMENT

Proposed development in the Juliet Creek watershed consists of 12 blocks totaling 281.8 ha (Table 1). The majority of proposed development is located north of the mainstem of Juliet and the North sub-basin. CP 156 is split between the North sub-basin and the residual area while CP 106 is located lower in the watershed, confined to the residual area. There is also a SBFEP block in July Creek scheduled for harvest in 2005. All other blocks are planned to be cut by 2006 (exact year not known). There is no proposed development planned for the South sub-basin up to the year 2006.

TABLE 1

Summary of Proposed Development 2001-2006
Juliet Creek Watershed

Cutting Permit and Blocks	Sub-basin	Proposed Area (ha)
156-2,3,4 and 8	North	122.1
156-1,5,6, and 7	Residual	90.3
106-5,6 and 7	Residual	57.6
A56181	July	11.8
Total		**281.8**

5.0 METHODS

The April 1999 Interior Watershed Assessment Procedure was the guiding document used for conducting office analyses and field surveys. Details are provided below.

5.1 Office Assessment

Preliminary analysis of Juliet Creek watershed was conducted in the office. An ortho map, air photos and five-year development plan map were provided by Tolko Industries Ltd. Information sources used in the study included:

1. Current (2000) air photos. These were used to locate potential sediment sources from roads and hillslopes (including mass wasting events), harvested riparian areas, and channel sites to inspect in the field.

2. Historical (1969) air photos for disturbance indicators in the mainstem of Juliet Creek and for locations of historical mass wasting.

3. Map information including:
   - 1:20,000 TRIM
   - Forest cover
   - Five year development plan
   - Silviculture information from Tolko Industries Ltd.

4. Communication with Tolko Industries Ltd. personnel, sub-contractors, and agencies regarding hydrologic concerns or previous work in the watershed.

5. Review of previous reports: Borrett Engineering Inc. (1998), Foresite (2001), Nicola Tribal Association (1998), Klohn-Crippen (1999) and M. Miles (1992).

The equivalent clearcut area (ECA) of the watershed was determined using historical forest development data. The ECA is a measure of the amount of harvesting that has occurred in a watershed, modified by the amount of hydrologic recovery from regrowth of conifers (see Appendix 2 of the 1999 IWAP Guidebook for details). It is used as a surrogate for inferring change in peak flows due to forestry. Inference is based on a compilation of hydrology studies carried out in Canada and the Pacific Northwest, especially where snowmelt is the dominant runoff process. In 1998, the ECA in Juliet Creek watershed was measured by Borrett Engineering Inc. at 10.1%.

The ECA and hydrologic recovery was calculated for cutblocks, burns, and cleared areas, following procedures in the IWAP Guidebook. Hydrologic recovery for openings was determined from average tree height (Forest Cover FIP data). A conservative leader increment of 20 cm per year was used to 'grow trees' and calculate current and proposed tree height since the most recent date of measurement.

Cutblock areas were obtained from file information: when missing, openings were digitized from Forest Cover Maps. Watershed, sub-basin and opening areas were measured from maps. A single H_{60}[1] elevation line was used for the entire watershed.

Roads were included in the ECA calculation as clearings; road lengths were measured from maps. Road areas were calculated using the following assumed widths: main roads = 20m, secondary roads = 10m, other roads = 5m.

5.2 Field

Fieldwork consisted of a helicopter flight (June 29, 2001) and a reconnaissance-level survey on the ground on August 6-7th and October 16th, 2001. Field surveys were used to verify regeneration of tree heights in cut blocks (for hydrologic recovery calculations), assess sediment input to streams and inspect channels. Changes were made to hydrologic recovery at openings when gross differences were observed between file and field information.

The ground survey was carried out to identify sediment sources to streams from roads and hillslopes, and inspect stability of channels at strategic locations. The field surveys were not intended to cover all areas of the watershed, but to assess those sites and roads most likely to have a hydrologic impact to Juliet Creek. Specific sites of interest to inspect were identified from previous reports, and from the air photo review.

We followed a Re-CAP method for inspecting channels, as suggested in the 1999 IWAP Guidebook. The Juliet Creek channel network was inspected at major

[1] The H_{60} elevation refers to the elevation for which 60% of the watershed is above.

tributaries, strategic accessible other locations, and near the confluence with the Coldwater River. At least 100m of channel was surveyed at each site; typically, surveys were 200-300m. Limited channel inspection was carried out in the July Creek sub-basin because there is no development planned to 2006 and a detailed channel assessment is reported by Klohn-Crippen (1999).

Riparian area conditions were observed during the sediment and channel surveys. Other riparian sites were selected from maps or photos that appeared logged on both sides of the channel.

6.0 RESULTS

The results of the field survey and related office calculations pertaining to the assessment of Juliet Creek watershed are presented in this section.

During the field survey, 31 km of road was traversed and the channel was inspected at eight sites (refer to the attached map for site locations). Results are presented below for the primary hydrological impact categories of peak flows, sediment sources, riparian areas and channels in the study area.

6.1 Peak Flows

Juliet Creek is not gauged, so a measured range of peak flows is not available. Using flow data on the Coldwater River and nearby Spius Creek as a guide, peak flows are most typically associated with spring snowmelt. However, the largest floods have been due to rainstorms or rain on snow events in the fall that occur infrequently. Discharge has been estimated for Juliet Creek by Harding et al. (1981) using regional relationships between drainage area and flow data for gauged basins up to 1980 (Table 2). Since 1980, however, instantaneous flows in the Coldwater have been exceeded two times, in 1990 and 1995. Estimated discharge may therefore be higher than shown in Table 2 for the respective reccurrence intervals.

Table 2
Estimated Instantaneous Discharge (m^3/s)*
of the Juliet Creek Watershed at the POI
(data up to 1980)

Recurrence Interval (Year)	Instantaneous Discharge (m^3/s)
2	25.7
10	36.8
50	52.6
100	58.0

*Harding et al. (1981)

ECA

The equivalent clearcut area (ECA) is used as a surrogate to estimate the impact of forest development on peak flows (Appendix A shows ECA details).

Total Watershed

The current ECA at the POI of Juliet Creek is 10.1%, which represents a low potential for increased peak flows over natural levels (Table 3). Note that the 1998 ECA was reported at 10.1% by Borrett Engineers Inc. With proposed development the ECA will increase by 2.5% to 12.6% which still represents a low concern for increased peak flows due to forestry development. If there was no proposed development the ECA would be 9.2% due to hydrologic recovery at planted openings (Figure 1).

The road density is low (0.60 km/km^2) and should not by itself influence peak flows due to the amount of roads.

Table 3
Current (2000) and *Proposed* (2006) ECA for Sub-basins and the Total Juliet Creek Watershed

Sub-basin	Area	ECA					
		Current 2001			*Proposed 2006*		
	(ha)	Total sub-basin (ha)	Total sub-basin (%)	>H_{60} elevation (%)	*Total sub-basin (ha)*	*Total sub-basin (%)*	*>H_{60} elevation (%)*
South	1502.0	159.2	10.6	0.4	*140.4*	*9.3*	*0.4*
North	2596.4	123.6	4.8	1.1	*243.4*	*9.4*	*4.1*
July	2090.1	258.1	12.3	5.4	*260.8*	*12.5*	*5.6*
Total Watershed	8916.2	901.6	10.1	2.1	*1121.7*	*12.6*	*4.4*

Sub-basins

The current ECA at sub-basins ranges from 4.8% in the North sub-basin to 12.3% in July sub-basin. ECA's at this level do not present a concern for peak flow changes due to forestry development. Proposed ECA decreases by less than 1% in the South sub-basin because there is no development planned there, and also due to hydrologic recovery. In July Creek, there is one proposed block that will increase the ECA to 12.5% from 12.3%. In the North sub-basin, there are four proposed blocks scheduled for harvest in 2006 that will increase the ECA by 4.6% to 9.4% (Figure 2).

6.2 Sediment Sources

Sediment sources to streams from roads were observed in the residual area and July Creek sub-basin (Table 4). The main forest road on the south and north sides of Juliet Creek in the residual area have sediment sources at crossings over steep, unstable, tributaries. SS1 and SS2 are related to blocked culverts along a partly overgrown road. Flow has been diverted over the road and is eroding the surface. A general recommendation is to deactivate the road and remove culverts; site-specific recommendations are shown in Table 4. SS3 is an eroding cutbank at a tributary stream that is recommended to be armored at the base to prevent further erosion.

On the south side of Juliet Creek, both SS4 and SS5 requires a new culvert (see photo19). Erosion at the culvert inlet and outlet at SS6 can be mitigated by installing armour at the inlet and seeding exposed soil at the outlet.

Sediment sources in the July sub-basin were also located at crossings, primarily associated with erosion at culvert inlets and outlets. Recommendations are provided at each site to stabilize sediment transport. However, deactivation is recommended along the entire south road system (i.e. SS7 to SS10) due to sections of ditch and road surface erosion connected to crossings and also because there is no development proposed in the current plan.

Only SS11 is recommended for deactivation in the north road network of July sub-basin, related to a collapsing wood culvert (photo 20, previously identified by Klohn-Crippen 1999, restoration site 3).

Although ditch erosion was apparent in the main road of the South sub-basin, there is low potential for sediment transport to streams because of the setback distance. The road north of the mainstem in the North sub-basin was partly overgrown and stable.

TABLE 4

Sediment Sources* in the Juliet Creek Watershed

Sediment Source	Location & Description	Recommendations for Rehabilitation
SS1	Residual, opening 57-1. Blocked culvert(s) has diverted a creek over and down road for 83m.	Clear culvert inlet and armor fillslope at culvert inlet.
SS2	Residual. Blocked culvert has eroded a portion of the road and diverted ditch flow across road. Creek is now flowing through culvert, but ditch flow is still eroding the road.	Repair road and construct sump at culvert inlet.
SS3	Residual. Eroding cutbank near bridge.	Armour base of bank.
SS4	Residual. Road surface wash is eroding piping culvert (hole in culvert).	Replace culvert.
SS5	Residual. Water over road during freshet at stream.	Install culvert.
SS6	Residual. Old debris torrent. Raveling cutbank upstream and downstream of culvert.	Armour banks upstream of culvert inlet and seed exposed soil at culvert outlet.
SS7	July sub-basin. Eroding fillslope at culvert inlet and outlet, eroding ditchline at culvert inlet. Culvert damaged.	Armour culvert inlet and outlet, breach berm above inlet, install sump at culvert inlet and replace damaged culvert.
SS8	July sub-basin. Eroding fillslope at crossdrain inlet.	Seed exposed soil, armour inlet, install sump at inlet and additional cross-drain upslope of inlet.
SS9	July sub-basin. Eroding cutbank and ditchline to culvert inlet, silt fence in ditch is full (>1m^3 sediment). Rilling fillslope at culvert outlet.	Install sump at culvert inlet, clear sediment behind silt fence and seed cutbank and fillslope.
SS10	July sub-basin. Rilling fillslope at culvert outlet and eroding ditchline at culvert inlet.	Seed fillslope, armour road surface approaches to culvert.
SS11	July sub-basin. Collasped wood culvert.	Remove/replace culvert.

* Only sites that directly deliver sediment to streams are reported, such as eroding ditchlines connected to culvert inlets, or rills in fillslopes adjacent to streams. Sediment at cross-drains is not listed unless inferred due to proximity to a stream or there is evidence of a sediment trail from the cross-drain outlet to the stream.

6.3 Mass Wasting

The air photo review and aerial flight showed that there are natural active geomorphic processes such as talus slopes, rock falls and avalanches associated with steep terrain and glacial features in the South, North and July sub-basins. No slides appear related to forestry activities.

Mass wasting event #1 is listed in Table 5 because it is close (i.e. 20m below) to a forest road. The road surface is relaxed, dipping to the fillslope. The slide surface is actively rilling and raveling direct to the stream (area ~100m^2). Slope stabilization with in-stream rock and log flow deflectors applied at the toe of the failure were in-progress at the time of the field survey (see photos 15+16). It is recommended to monitor the performance of the works in subsequent freshets

6.4 Riparian Areas

There is an overall low concern associated with riparian disturbance due to forest harvesting along mainstem channels. One site (RIP1, Opening 5, Polygon 725), has a feathered buffer that ranges from no trees to the bank of Juliet Creek to residual stems up to 5m in height (photo 24). No stability concerns were noted in the riparian area nor were there any obvious channel impacts.

Logging has occurred along small tributary creeks (<1.0m-3.0m) but, in general, no stability concerns were observed. An exception is channel disturbance for approximately 50-75m (bank erosion and trees felled/windthrown into creek) associated with riparian logging (opening 6, polygon 669) at Tributary 4.

In the Level 1 fish habitat assessment report for Juliet Creek, the Nicola Tribal Association (1998) noted isolated instances of forest harvesting to one streambank. A summary extracted from pages 26-27 is printed below.

> "The impacts of forest harvesting in the Upper Coldwater River [i.e. Juliet Creek and Upper Coldwater] study area pale in comparison to the level of impact that can be observed on the Coldwater River mainstem while driving on the Coquihalla Highway or Coldwater Road. It is likely that the impaired condition of the Lower Coldwater River is more limiting to fish production than the combined effects of forest harvesting in the Upper Coldwater River drainage."

The report recommended two streambank sites as high priority for stabilization, at 1640m elevation on Juliet Creek (Juliet reach 1b, shown as MW1 on map) and at the South sub-basin near the confluence with Juliet Creek main (tributary 6, reach 2).

TABLE 5

Mass Wasting Events in Juliet Creek

Mass Wasting Event	Location & Description	Recommendation
MW1	Residual. Large stream bank failure to Juliet Creek (appears natural). Stabilization works ongoing at time of field visit.	Monitor performance after annual freshets.

6.5 Channels

Mainstem channels were inspected at nine locations (~ 1.6km) in the residual area and sub-basins (Table 6). Tributaries were also inspected below proposed forest development on the north side of Juliet Creek.

Figure 4 shows the overall gentle gradient of the mainstem of Juliet Creek (s= 2%). However, the Juliet Creek and July Creek channels are active and aggraded with sediment accumulation(see photos). The channels appear to have considerable stream power: large boulders (e.g. diameters > 50cm) are moved annually during the spring freshet and large debris in channels were frequently parallel to flow. Along the valley flats are remnants of previous very high flows, possibly from 1995 or 1997. This is evident in levees, abandoned channels, widened channels and avulsions.

M. Miles (1992) observed that the 1990 flood caused extensive erosion on Juliet Creek above the highway bridge. The author also reports that further vertical and lateral channel instability is expected in lower Juliet Creek due to a 'slug' of coarse sediment that is moving downstream through the system.

Juliet Creek above the confluence with July Creek was an average width of 15.8m with a gradient of 2% in an unconfined valley flat. The channel is aggraded with accumulations of coarse sediment. The bed is dominated by large boulders that also control flow: fine sediment and large woody debris was virtually absent from the channel. Disturbance indicators included extensive gravel and boulder bars, multiple channels, levees and extensive riffles. Eroding banks were also observed in the initial 100m.

Approximately 7.0 km upstream, the Juliet Creek mainstem exhibits disturbance characteristics similar to the POI such as bars, multiple channels and avulsions (e.g. CSS6). The channel is also widened (average= 66.5m) which has resulted in some debris jams. In Juliet North (CSS4) the channel is still wide (i.e. 62m) but less disturbed and aggraded at than below the junction with Juliet South. Gravel bars are beginning to become colonized with pioneer vegetation species, suggesting an early trend towards increased stability.

An additional 2.8km upstream at CSS1 through to CSS3, the Juliet Creek channel is stable to partially aggraded. Banks were stable and large rocks were black and mossed. Sand is the dominant bed material moving at floods. Channel sections with moderate (A2) aggradation are related to natural logjams that have captured sediment on the upstream side. Logjams were generally not large, except one jam near the mouth of CSS3 that has previously diverted flow but is now stable.

In Juliet south(CSS5), the channel was observed to be stable to partially aggraded, however, near the mouth in a depositional section (@102m-205m), there was still evidence of channel widening, bars, and avulsions.

Tributary channels were also inspected (channel inventory forms not completed for tributaries). Tributaries 1 through 4 on the north flank of the mainstem Juliet channel were of particular interest because they drain areas of proposed development. Tributary 1 is steep (> 20%) and appears to have recently torrented or be a debris flow, although it was dry at the time of the survey. Large boulders (i.e.> 60cm diameter) control flow, banks were eroded and avulsions evident (see photo 10). The channel is very unstable and erosion of the cutbank at the road was observed. Below the road, the channel splits into multiple channels and sediment fans over the forest floor. The channel appears to be still active.

Tributary 2 was dry at the road but a installing culvert is suggested, because of flow suspected over the road at spring. Tributary 3 appears blocked, causing diverted flow and erosion over the road surface (SS1). Tributary channel 4 (CSS7) was stable at the mouth of Juliet Creek and for most of the 180m survey length. Channel disturbance (windthrow into creek, eroding banks) was observed for approximately 50m to 75m near the access road at 154m and adjacent to riparian logging above the road. Deactivation of the access road is recommended to mitigate sediment input to the channel.

TABLE 6

Channel Survey Results for Juliet Creek Watershed

Channel Survey Site	Survey length (m)	Location/ Description	Morphology and Disturbance Level
CSS1	100	North sub-basin mainstem near Opening 1. Wb=5.7m, d=25cm, s=3.5-5%, D=36cm	CPb:S-A2
CSS2	100	North trib. in North sub-basin. Wb=5.3m, d=51cm, s=7.5%, D=25cm	SPb:S-A2
CSS3	100	North sub-basin mainstem above North Trib. Wb=7.4m, d=41cm, s=6%, D=37cm	SPb:S-A2
CSS4	229	North sub-basin near mouth. Wb=16m, d=62cm, s=5.3%, D=48cm	CPb:A1-A2
CSS5	205	South sub-basin near mouth. Wb=39.5m, d=42cm, s=5.3%, D=52cm	CPb:S-A2
CSS6	152	Juliet mainstem below North and South sub-basins. Wb=28.9m, d=66.5cm, s=4%, D=47cm	CPb:A1-A3
CSS7	180	Tributary 4, draining proposed 156-5 &6. Wb= 2.6m, d=44cm, s=15% D=47cm.	SPb: S- A2
CSS8	306	July Creek at confluence with Juliet Creek. Wb=8.3m, d=98cm, s=3%, D=52cm	RPc:A1-A2
CSS9	301	Juliet Creek above July Creek. Wb=15.8m, d=128cm, s=2%, D=73cm	RPc:A1-A2

Near the mouth, July Creek is low gradient (~3%), unconfined in a valley flat, and flow is controlled by large boulders up to 520mm in diameter. The channel is braided in sections, and large woody debris is mainly absent. Disturbance indicators are extensive bars, extensive riffles, and minimal pool area. A levee at 234m is evidence of former debris flow in the channel. Overall, the channel is aggraded with sediment, but channel bars show some revegetation by herbaceous species. Klohn-Crippen (1999) reports similar channel conditions for this reach. Upstream (more than 900m above the mouth) July Creek is more confined with exposed bedrock sections. Debris jams and sediment wedges are common (Klohn-Crippen 1999), and were also evident in the aerial survey. A waterfall/chute was seen in the channel above existing logging from the helicopter (see map).

From the channel assessment report by Klohn–Crippen (1999), there is natural instability of slopes in the July sub-basin that threatens the channel stability of the mainstem July Creek. No forestry - related slides were observed. Sediment deposited into July Creek from torrented gullies and raveling slopes has developed debris jams and sediment wedges in the lower July Creek channel (Klohn-Crippen 1999). Sediment delivery from a tributary channel has resulted in a blocked culvert at the road (reported as SS7 in Table 4). The conclusion of the report is that in July creek natural sediment sources, "...have had a larger influence on channel conditions over the long term than sediments from upstream forestry activities" (p. 46).

7.0 PROPOSED FOREST DEVELOPMENT

Most of proposed development is located on the north flank of the Juliet Creek mainstem in the residual area and North sub-basin. The amount of proposed development (281.1 ha) is not by itself a hydrologic concern for an increase in peak flows (proposed ECA's are less than 13% in sub-basins and over the total watershed). No development is proposed in the South sub-basin.

The primary concern is related to the location of blocks of CP 106 and CP 156-4,5,6 and 8 above or on steep terrain and potential to impact slope and channel stability. Although the blocks are primarily on gentle terrain, they drain to much steeper slopes. Blocks drained by Tributaries 1, 3 and 4 are a concern because these streams are either inherently unstable or there are existing sediment problems at roads. The potential to initiate a debris flow or torrent associated with harvesting can be managed by: setting back block borders to the top of the outer gorge and avoiding harvest on channel sidewalls, ensuring that logging debris does not enter the channel and; by using low-impact roads that are deactivated immediately after harvesting. It is especially important to ensure natural drainage is maintained at all roads. Temporary crossings are recommended to 106-6 and 156-5 at Tributaries 1 and 3, respectively. And it is suggested to address sediment concerns SS1 to SS3 inclusive prior to initiating new road building on the north slope of

the residual area and to access 156-1. Because of steep terrain and proximity to Tributary 1, it is recommended to have a terrain specialist assess the potential to initiate a landslide at the south portion of 106-6.

Due to gentler terrain, blocks 156-2,3,4 & 8 represent a lower hydrologic concern, however, it is recommended that SS6 is stabilized, culverts are replaced/installed at SS5 and SS6 prior to harvest, and that roads are deactivated following the completion of harvest.

Block A56181 is the only block proposed in July Creek. Because of the potential for debris flows, it is suggested to move the south border away from the creek.

8.0 CONCLUSIONS

Based on the office work and field surveys, the following conclusions are presented for peak flows, sediment sources, and riparian and channel stability in the Juliet Creek watershed.

In general, there has been a low amount of forest development in the Juliet Creek watershed. Both current and proposed ECA's in sub-basins and over the total watershed are less than 13%, which does not represent a hydrologic concern for an increase in peak flows over natural levels.

Forestry-related mass wasting was not observed in the field surveys, although slides, torrents and debris flows are natural processes on the steep slopes draining to the valleys. Two road systems are recommended for deactivation (or upgrading) due to a number of sediment sources at crossings and potential impacts to roads from debris flows in steep tributaries. These are: the access route to 156-1 in the residual area and the south road in the July Creek sub-basin. Three sediment sources (SS4, SS5 and SS11) can be addressed by deactivating or replacing culverts. Other roads were stable or set back sufficiently from streams and therefore pose a low concern for sediment delivery.

There has been a low amount of riparian harvesting around mainstem channels. No impacts to Juliet Creek were noted at the single case of riparian harvesting around the mainstem, located in the North sub-basin. Logging has occurred along small tributary creeks (<1.0-3.0m Wb) but, in general, no stability concerns were observed. An exception is channel disturbance for approximately 50-75m (bank erosion and trees felled/windthrown into creek) associated with riparian logging (opening 6, polygon 669) at Tributary 4.

Streams are active, aggraded and laterally unstable, particularly in the valleys of Juliet Creek and sub-basins. Mainstem channels are charged with sediment with potential to migrate downstream at annual freshets. Instability is natural, and related to high stream power at floods. Instability was also observed at steep tributaries (torrents and debris flows). Forestry activities have had a low impact to channel conditions, however, except for localized sedimentation effects at road crossings as discussed above.

Proposed forest development is a low concern for increasing peak flows in the watershed. However, there are hydrologic concerns related to the location of some of the blocks over steep terrain, or above existing sediment problems, and the potential to initiate or accelerate debris flow or torrents. Recommendations are provided in the following section to address existing and potential hydrologic concerns.

9.0 RECOMMENDATIONS

To protect the water quality in the Juliet Creek watershed, it is recommended to:

1. Stabilize sediment sources SS1, 2 and 3 prior to road building or harvesting on the north slope of the residual area. This can be done by deactivating or upgrading the access route to proposed 156-1.

2. Move the south border of A56181 away from the creek, and stabilize SS7 to SS10 prior to harvesting. Should development not proceed, or following the completion of harvest, deactivate the south road system in the July Creek sub-basin due to sediment delivery potential to streams from an eroding road surface and ditchline, and to mitigate road wash-out potential from torrents at tributaries.

3. Install or replace culverts at SS5 and SS4 and stabilize SS6 prior to harvesting upslope blocks 156-2 and 3.

4. Assess the potential for harvesting in the south portion of Block 106-6 to initiate a landslide by a terrain specialist.

5. To mitigate debris flow potential at steep tributaries, ensure that logging debris at the proposed blocks does not enter channels and natural drainages are maintained at roads to 106- 5 & 6, 156- 5, 6, & 7. Set borders back to the top of the outer gorge, where applicable, to avoid harvest on channel sidewalls.

6. Use temporary crossings to 106-6 at Tributary 1 and to 156-6 at Tributary 4 because of proximity to steep channel terrain, and deactivate these crossings immediately after harvesting.

7. Deactivate all proposed roads after harvesting.

8. Remove/replace the collapsed crossing at SS11 in July Creek sub-basin.

9. Periodically monitor the performance of the in-stream works at MW1 after the annual flood.

10.0 REFERENCES

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FIGURE 1
2001-2006 ECA for the Juliet Creek watershed

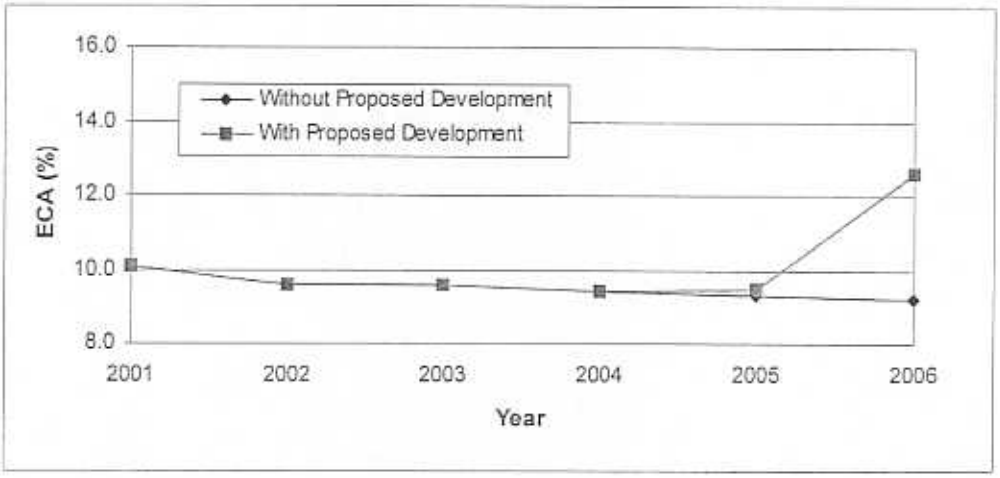


FIGURE 2
2001-2006 ECA for the North Sub-basin

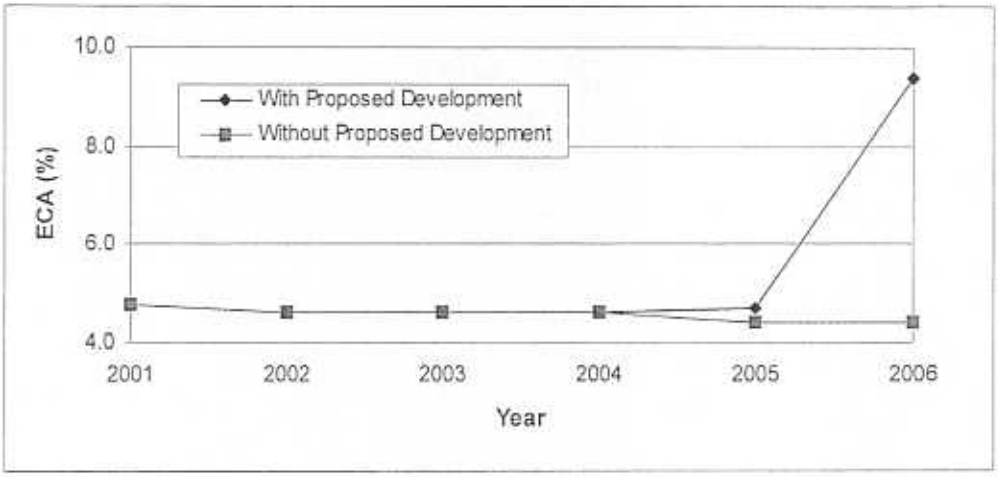


FIGURE 3
2001-2006 ECA for the July Creek Sub-basin

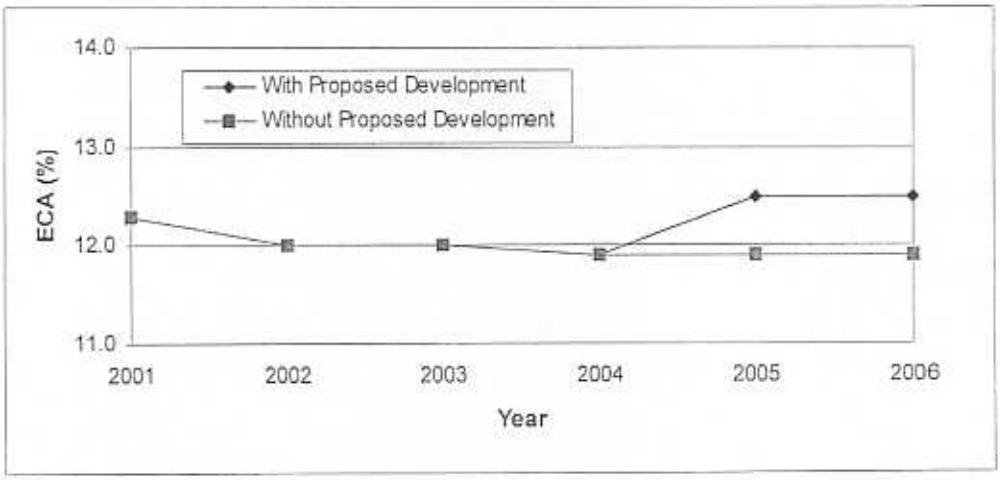
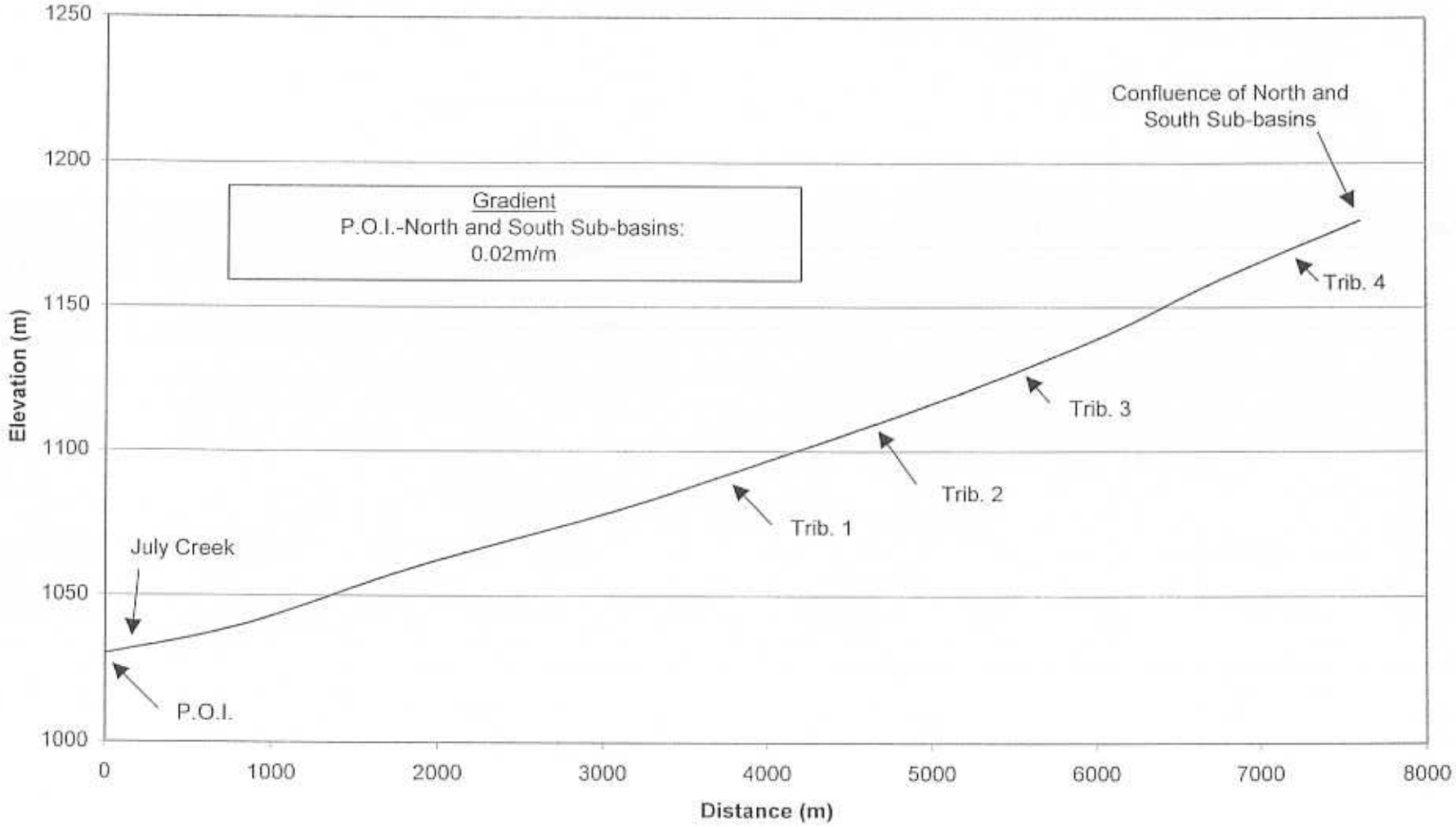


Figure 4
Juliet Creek Longitudinal Profile



APPENDIX A

ECA TEMPLATES

Watershed Assessment: ECA Determination

Juliet Creek *Watershed*

Watershed area (ha): 8916

South Sub-basin *Sub-basin*

1. ECA without development

Regen. Growth/year (m): 0.2
Sub-basin area (ha) 1502.0
Road width(m) *Main:* 20.0 *2ndary* 10.0 *Other:* 5.0

H60 Elevation (m) 1500
1st year of study 2001

Threshold ECA (%) 20

Note: Data entry fields are shaded.
For NSR areas enter NSR in height column and no reference year in year column.
*Regeneration values: Leader= increment; Height= average height of regen.; year= reference year.

CP/ Block	*Opening/ Polygon*	*Year Logged*	*Area (ha)* <H60	*Area (ha)* >H60	*Regeneration* Measured (m)* Leader	*Year*	*Height*	2001 ECA Adjusted <H60	2001 ECA (ha.) >H60	2002 ECA Adjusted <H60	2002 ECA (ha.) >H60	2003 ECA Adjusted <H60	2003 ECA (ha.) >H60	2004 ECA Adjusted <H60	2004 ECA (ha.) >H60	2005 ECA Adjusted <H60	2005 ECA (ha.) >H60
	7/750		68.30			1987	0.50	51.23	0.00	51.23	0.00	51.23	0.00	51.23	0.00	51.23	0.00
	8/842	1979	50.30			1991	0.80	50.30	0.00	37.73	0.00	37.73	0.00	37.73	0.00	37.73	0.00
	1/839		5.90			1987	0.60	4.43	0.00	4.43	0.00	4.43	0.00	4.43	0.00	4.43	0.00
	1/461		9.10	2.00		1994	2.40	6.83	1.50	6.83	1.50	6.83	1.50	6.83	1.50	6.83	1.50
	2/470	1980	20.00	4.80		1996	1.20	20.00	4.80	20.00	4.80	20.00	4.80	20.00	4.80	15.00	3.60
	5/725	1984	1.20			1987	0.60	0.90	0.00	0.90	0.00	0.90	0.00	0.90	0.00	0.90	0.00
183-4		2000	6.20				NSR	6.20	0.00	6.20	0.00	6.20	0.00	6.20	0.00	6.20	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROADS	*length (km)*		Area (ha)														
	<H60	*>H60*	<H60	>H60													
Main	6.4	0.1	12.80	0.20			road	12.80	0.20	12.80	0.20	12.80	0.20	12.80	0.20	12.80	0.20
Secondary			0.00	0.00			road	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other			0.00	0.00			road	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Included above in ECA calculations as clearings																	
Road																	
Rail																	

Without Proposed Blocks

	Area (ha) Total	<H60	>H60
with roads	180.8	173.8	7.0
w/o roads	167.8	161.0	6.8

	2001 ECA Adjusted <H60	2001 ECA (ha.) >H60	2002 ECA Adjusted <H60	2002 ECA (ha.) >H60	2003 ECA Adjusted <H60	2003 ECA (ha.) >H60	2004 ECA Adjusted <H60	2004 ECA (ha.) >H60	2005 ECA Adjusted <H60	2005 ECA (ha.) >H60
ECAs(ha)	152.7	6.5	140.1	6.5	140.1	6.5	140.1	6.5	135.1	5.3
Total ECA(ha)	159.2		146.6		146.6		146.6		140.4	
Total ECA (%):	10.6		9.8		9.8		9.8		9.3	
ECA (%) >H60:		0.4		0.4		0.4		0.4		0.4
Total available ECA (ha)	141.2		153.8		153.8		153.8		160.0	
Roads										
ECAs(ha)	12.8	0.2	12.8	0.2	12.8	0.2	12.8	0.2	12.8	0.2
length (km)	6.4	0.1	6.4	0.1	6.4	0.1	6.4	0.1	6.4	0.1
density(km/km	0.43	0.01	0.43	0.01	0.43	0.01	0.43	0.01	0.43	0.01
Total road density (km/km2)	0.43		0.43		0.43		0.43		0.43	

Roads

Total area (ha)	13.00
Total length (km)	6.5
Tot.density (km/km2)	0.43

South Sub-basin 2. ECA with Proposed Sub-basin Blocks

COMPANY	CP/BLOCK	Year Logged	Area (ha) <H60	Area (ha) >H60				2001 ECA Adjusted (ha.) <H60	2001 ECA Adjusted (ha.) >H60	2002 ECA Adjusted (ha.) <H60	2002 ECA Adjusted (ha.) >H60	2003 ECA Adjusted (ha.) <H60	2003 ECA Adjusted (ha.) >H60	2004 ECA Adjusted (ha.) <H60	2004 ECA Adjusted (ha.) >H60	2005 ECA Adjusted (ha.) <H60	2005 ECA Adjusted (ha.) >H60
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Roads			Area (ha)		*Length (km)*												
Secondary			<H60	>H60	Total	<H60	>H60										
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

With Proposed Blocks

Current plus up to the to the year 2005

	Area (ha) Total	<H60	>H60
with roads	180.8	173.8	7.0
w/o roads	167.8	161.0	6.8

	2001 ECA Adjusted (ha.) <H60	2001 ECA Adjusted (ha.) >H60	2002 ECA Adjusted (ha.) <H60	2002 ECA Adjusted (ha.) >H60	2003 ECA Adjusted (ha.) <H60	2003 ECA Adjusted (ha.) >H60	2004 ECA Adjusted (ha.) <H60	2004 ECA Adjusted (ha.) >H60	2005 ECA Adjusted (ha.) <H60	2005 ECA Adjusted (ha.) >H60
ECAs (ha)	152.7	6.5	140.1	6.5	140.1	6.5	140.1	6.5	135.1	5.3
Total ECA (ha):	159.2		146.6		146.6		146.6		140.4	
Total ECA (%):	10.6		9.8		9.8		9.8		9.3	
ECA (%) >H60:		0.4		0.4		0.4		0.4		0.4
Total available ECA (ha)	141.2		153.8		153.8		153.8		160.0	
Roads										
ECAs (ha)	12.8	0.2	12.8	0.2	12.8	0.2	12.8	0.2	12.8	0.2
length (km)	6.4	0.1	6.4	0.1	6.4	0.1	6.4	0.1	6.4	0.1
density(km/km	0.43	0.01	0.43	0.01	0.43	0.01	0.43	0.01	0.43	0.01
Total road density (km/km2)	0.43		0.43		0.43		0.43		0.43	

Roads (Current plus up to the year 2005)

Total area (ha)	13.00
Total length (km)	6.50
Tot.density (km/km2)	0.43

Juliet Creek Watershed

Regen Growth/year (m): 0.2 | H60 Elevation (m) 1500 | Threshold ECA (%): 20

Sub-basin area (ha): 2596.4 | 1st year of study 2001

Road width(m) Main: 20.0 | 2ndary 10.0 | Other: 5.0

North Sub-basin *Sub-basin*

Note: Data entry fields are shaded.

1. ECA without development

For NSR areas enter NSR in height column and no reference year in year column.

*Regeneration values: Leader= increment; Height= average height of regen.; year= reference year.

CP/ Block	Opening/ Polygon	Year Logged	Area (ha) <H60	Area (ha) >H60	Regeneration* Measured(m) Leader	Year	Height	2001 ECA Adjusted <H60	2001 ECA (ha.) >H60	2002 ECA Adjusted <H60	2002 ECA (ha.) >H60	2003 ECA Adjusted <H60	2003 ECA (ha.) >H60	2004 ECA Adjusted <H60	2004 ECA (ha.) >H60	2005 ECA Adjusted <H60	2005 ECA (ha.) >H60
	1/632	1983	8.20			1987	0.30	6.15	0.00	6.15	0.00	6.15	0.00	6.15	0.00	6.15	0.00
	1/662	1983	13.00			1996	2.20	9.75	0.00	9.75	0.00	9.75	0.00	9.75	0.00	9.75	0.00
	411	B	2.70				N	2.70	0.00	2.70	0.00	2.70	0.00	2.70	0.00	2.70	0.00
	2/665	1982	23.70			1987	0.40	17.78	0.00	17.78	0.00	17.78	0.00	17.78	0.00	17.78	0.00
	3/729	1984	13.00			1987	0.40	9.75	0.00	9.75	0.00	9.75	0.00	9.75	0.00	9.75	0.00
	5/725	1984	24.10			1987	0.60	18.08	0.00	18.08	0.00	18.08	0.00	18.08	0.00	18.08	0.00
	6/669	1981	13.80			1991	0.80	13.80	0.00	10.35	0.00	10.35	0.00	10.35	0.00	10.35	0.00
	4/728	1987	3.90	14.90		1990	0.10	3.90	14.90	3.90	14.90	3.90	14.90	3.90	14.90	2.93	11.18
	630	B	7.60	13.90		1991	9.00	0.76	1.39	0.76	1.39	0.76	1.39	0.76	1.39	0.76	1.39
	629	B	4.00	43.00		1991	7.00	0.40	4.30	0.40	4.30	0.40	4.30	0.40	4.30	0.40	4.30
	627	B		7.80			N	0.00	7.80	0.00	7.80	0.00	7.80	0.00	7.80	0.00	7.80
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROADS	*length (km)*		Area (ha)														
	<H60	*>H60*	*<H60*	*>H60*													
Main	6.00	0.05	12.00	0.10			road	12.00	0.10	12.00	0.10	12.00	0.10	12.00	0.10	12.00	0.10
Secondary			0.00	0.00			road	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other			0.00	0.00			road	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Included above in ECA calculations as clearings																	
Road																	
Rail																	

Without Proposed Blocks

	Area (ha) Total	<H60	>H60
with roads	205.7	126.0	79.7
w/o roads	193.6	114.0	79.6

	2001 ECA Adjusted <H60	2001 ECA (ha.) >H60	2002 ECA Adjusted <H60	2002 ECA (ha.) >H60	2003 ECA Adjusted <H60	2003 ECA (ha.) >H60	2004 ECA Adjusted <H60	2004 ECA (ha.) >H60	2005 ECA Adjusted <H60	2005 ECA (ha.) >H60
ECAs(ha)	95.1	28.5	91.6	28.5	91.6	28.5	91.6	28.5	90.6	24.8
Total ECA(ha)	123.6		120.1		120.1		120.1		115.4	
Total ECA (%):	4.8		4.6		4.6		4.6		4.4	
ECA (%) >H60:		1.1		1.1		1.1		1.1		1.0
Total available ECA (ha)	395.7		399.2		399.2		399.2		403.9	
Roads										
ECAs(ha)	12.0	0.1	12.0	0.1	12.0	0.1	12.0	0.1	12.0	0.1
length (km)	6.0	0.1	6.0	0.1	6.0	0.1	6.0	0.1	6.0	0.1
density(km/km	0.23	0.00	0.23	0.00	0.23	0.00	0.23	0.00	0.23	0.00
Total road density (km/km2)	0.23		0.23		0.23		0.23		0.23	

Roads

Total area (ha)	12.10
Total length (km)	6.05
Tot.density (km/km2)	0.23

North Sub-basin Sub-basin
2. ECA with Proposed Blocks

COMPANY	CP/BLOCK	Year Logged	Area (ha) <H60	Area (ha) >H60				2001 ECA Adjusted <H60	2001 ECA (ha.) >H60	2002 ECA Adjusted <H60	2002 ECA (ha.) >H60	2003 ECA Adjusted <H60	2003 ECA (ha.) >H60	2004 ECA Adjusted <H60	2004 ECA (ha.) >H60	2005 ECA Adjusted <H60	2005 ECA (ha.) >H60
Tolko	156-8	2006		31.80				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tolko	156-3	2006	25.50					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tolko	156-2	2006	14.30	3.80				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tolko	156-4	2006	3.20	43.50				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Roads			Area (ha)		Length (km)												
Secondary			<H60	>H60	Total	<H60	>H60										
		2005	3.20	2.70	5.90	3.20	2.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.20	2.70
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

With Proposed Blocks

Current plus up to the to the year 2005

	Area (ha) Total	<H60	>H60
with roads	333.7	172.2	161.5
w/o roads	315.7	157.0	158.7

	2001 ECA Adjusted <H60	2001 ECA (ha.) >H60	2002 ECA Adjusted <H60	2002 ECA (ha.) >H60	2003 ECA Adjusted <H60	2003 ECA (ha.) >H60	2004 ECA Adjusted <H60	2004 ECA (ha.) >H60	2005 ECA Adjusted <H60	2005 ECA (ha.) >H60
ECAs (ha)	95.1	28.5	91.6	28.5	91.6	28.5	91.6	28.5	93.8	27.5
Total ECA (ha):	123.6		120.1		120.1		120.1		121.3	
Total ECA (%):	4.8		4.6		4.6		4.6		4.7	
ECA (%) >H60:		1.1		1.1		1.1		1.1		1.1
Total available ECA (ha)	395.7		399.2		399.2		399.2		398.0	
Roads										
ECAs (ha)	12.0	0.1	12.0	0.1	12.0	0.1	12.0	0.1	15.2	2.8
length (km)	6	0.05	6	0.05	6	0.05	6	0.05	9.2	2.75
density(km/km	0.23	0.00	0.23	0.00	0.23	0.00	0.23	0.00	0.35	0.11
Total road density (km/km2)	0.23		0.23		0.23		0.23		0.46	

Roads (Current plus up to the year 2005)

Total area (ha)	18.00
Total length (km)	11.95
Tot.density (km/km2)	0.57

Juliet Creek Watershed

Regen Growth/year (m): 0.2 | H60 Elevation (m) 1500 | Threshold ECA (%): 20

Sub-basin area (ha): 2090.1 | 1st year of study 2001

Road width(m) Main: 20.0 | 2ndary 10.0 | Other: 5.0

July Creek *Sub-basin*

1. ECA without development

Note: Data entry fields are shaded.

For NSR areas enter NSR in height column and no reference year in year column.

*Regeneration values: Leader= increment; Height= average height of regen.; year= reference year.

CP/ Block	Opening/ Polygon	Year Logged	Area (ha) <H60	Area (ha) >H60	Regeneration* Measured(m) Leader	Year	Height	2001 ECA Adjusted <H60	2001 ECA (ha.) >H60	2002 ECA Adjusted <H60	2002 ECA (ha.) >H60	2003 ECA Adjusted <H60	2003 ECA (ha.) >H60	2004 ECA Adjusted <H60	2004 ECA (ha.) >H60	2005 ECA Adjusted <H60	2005 ECA (ha.) >H60
	29/302	1991		34.2		1993	0.1	0.00	34.20	0.00	34.20	0.00	34.20	0.00	34.20	0.00	34.20
	45/811		0.60				N	0.60	0.00	0.60	0.00	0.60	0.00	0.60	0.00	0.60	0.00
	45/810	1996	1.00				N	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
	33/856	1989	21.30			2001	1.50	21.30	0.00	21.30	0.00	21.30	0.00	21.30	0.00	21.30	0.00
	45/901		4.50				N	4.50	0.00	4.50	0.00	4.50	0.00	4.50	0.00	4.50	0.00
	45/902		1.90				N	1.90	0.00	1.90	0.00	1.90	0.00	1.90	0.00	1.90	0.00
	855	Logged	3.80			2001	0.50	3.80	0.00	3.80	0.00	3.80	0.00	3.80	0.00	3.80	0.00
	9/827	1980		25.90		1994	1.40	0.00	25.90	0.00	19.43	0.00	19.43	0.00	19.43	0.00	19.43
	11/704	1977	54.40			1992	2.00	40.80	0.00	40.80	0.00	40.80	0.00	40.80	0.00	40.80	0.00
	42/890	1995		7.50			N	0.00	7.50	0.00	7.50	0.00	7.50	0.00	7.50	0.00	7.50
	766	B		17.60			N	0.00	17.60	0.00	17.60	0.00	17.60	0.00	17.60	0.00	17.60
	14/768	1988	0.70	9.70		1990	0.20	0.70	9.70	0.70	9.70	0.70	9.70	0.53	7.28	0.53	7.28
	38/841		7.60			1996	0.30	7.60	0.00	7.60	0.00	7.60	0.00	7.60	0.00	7.60	0.00
	38/884		0.75			1996	0.30	0.75	0.00	0.75	0.00	0.75	0.00	0.75	0.00	0.75	0.00
	44/891		2.00				N	2.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00
	44/892	1995	6.00				N	6.00	0.00	6.00	0.00	6.00	0.00	6.00	0.00	6.00	0.00
	38/885		2.90			1996	0.90	2.90	0.00	2.90	0.00	2.90	0.00	2.90	0.00	2.90	0.00
	43/887		10.60				N	10.60	0.00	10.60	0.00	10.60	0.00	10.60	0.00	10.60	0.00
	43/888		1.00	5.20			N	1.00	5.20	1.00	5.20	1.00	5.20	1.00	5.20	1.00	5.20
	10/817		26.80	9.50		1986	0.30	20.10	7.13	20.10	7.13	20.10	7.13	20.10	7.13	20.10	7.13
	695	Logged	3.90				N	3.90	0.00	3.90	0.00	3.90	0.00	3.90	0.00	3.90	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROADS	*length (km)*		Area (ha)														
	<H60	>H60	<H60	>H60													
Main	7.5	3.2	15.00	6.40			road	15.00	6.40	15.00	6.40	15.00	6.40	15.00	6.40	15.00	6.40
Secondary			0.00	0.00			road	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other			0.00	0.00			road	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Included above in ECA calculations as clearings																	
Road	2.2	0.6															
Rail																	

Juliet Creek Watershed

Without Proposed Blocks

	Area (ha)		
	Total	<H60	>H60
with roads	280.8	164.8	116.0
w/o roads	259.4	149.8	109.6

Roads

Total area (ha)	21.40
Total length (km)	13.5
Tot.density (km/km2)	0.65

	2001 ECA		2002 ECA		2003 ECA		2004 ECA		2005 ECA	
	Adjusted	(ha.)	Adjusted	(ha.)	Adjusted	(ha.)	Adjusted	(ha.)	Adjusted	(ha.)
	<H60	>H60	<H60	>H60	<H60	>H60	<H60	>H60	<H60	>H60
ECAs(ha)	144.5	113.6	144.5	107.2	144.5	107.2	144.3	104.7	144.3	104.7
Total ECA(ha)	258.1		251.6		251.6		249.0		249.0	
Total ECA (%):	12.3		12.0		12.0		11.9		11.9	
ECA (%) >H60:		5.4		5.1		5.1		5.0		5.0
Total available ECA (ha)	159.9		166.4		166.4		169.0		169.0	
Roads										
ECAs(ha)	15.0	6.4	15.0	6.4	15.0	6.4	15.0	6.4	15.0	6.4
length (km)	9.7	3.8	9.7	3.8	9.7	3.8	9.7	3.8	9.7	3.8
density(km/km	0.46	0.18	0.46	0.18	0.46	0.18	0.46	0.18	0.46	0.18
Total road density (km/km2)	0.65		0.65		0.65		0.65		0.65	

July Creek Sub-basin
2. ECA with Proposed Blocks

COMPANY	CP/BLOCK	Year Logged	Area (ha) <H60	Area (ha) >H60				2002 ECA Adjusted <H60	2002 ECA (ha.) >H60	2003 ECA Adjusted <H60	2003 ECA (ha.) >H60	2004 ECA Adjusted <H60	2004 ECA (ha.) >H60	2005 ECA Adjusted <H60	2005 ECA (ha.) >H60	2006 ECA Adjusted <H60	2006 ECA (ha.) >H60
SBFEP	A56181	2005		11.80				0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.80	0.00	11.80
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Roads			Area (ha)		*Length (km)*												
Secondary			<H60	>H60	Total	<H60	>H60										
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

With Proposed Blocks

Current plus up to the to the year 2006

	Area (ha) Total	<H60	>H60
with roads	292.6	164.8	127.8
w/o roads	271.2	149.8	121.4

	2002 ECA Adjusted <H60	2002 ECA (ha.) >H60	2003 ECA Adjusted <H60	2003 ECA (ha.) >H60	2004 ECA Adjusted <H60	2004 ECA (ha.) >H60	2005 ECA Adjusted <H60	2005 ECA (ha.) >H60	2006 ECA Adjusted <H60	2006 ECA (ha.) >H60
ECAs (ha)	144.5	107.2	144.5	107.2	144.3	104.7	144.3	116.5	144.3	116.5
Total ECA (ha):	251.6		251.6		249.0		260.8		260.8	
Total ECA (%):	12.0		12.0		11.9		12.5		12.5	
ECA (%) >H60:		5.1		5.1		5.0		5.6		5.6
Total available ECA (ha)	166.4		166.4		169.0		157.2		157.2	
Roads										
ECAs (ha)	15.0	6.4	15.0	6.4	15.0	6.4	15.0	6.4	15.0	6.4
length (km)	9.7	3.8	9.7	3.8	9.7	3.8	9.7	3.8	9.7	3.8
density(km/km	0.46	0.18	0.46	0.18	0.46	0.18	0.46	0.18	0.46	0.18
Total road density (km/km2)	0.65		0.65		0.65		0.65		0.65	

Roads (Current plus up to the year 2006)

Total area (ha)	21.40
Total length (km)	13.50
Tot.density (km/km2)	0.65

Juliet Creek Watershed

Regen Growth/year (m):	0.2	H60 Elevation (m)	1500
Sub-basin area (ha):	2727.7	1st year of study	2001
Road width(m) Main:	20.0	2ndary 10.0	Other: 5.0

Threshold ECA (%): 20

Residual Area *Sub-basin*

1. ECA without development

Note: Data entry fields are shaded.

For NSR areas enter NSR in height column and no reference year in year column.

*Regeneration values: Leader= increment; Height= average height of regen.; year= reference year.

CP/ Block	*Opening/ Polygon*	*Year Logged*	*Area (ha)*		*Regeneration* Measured (m)*			2001 ECA Adjusted (ha.)		2002 ECA Adjusted (ha.)		2003 ECA Adjusted (ha.)		2004 ECA Adjusted (ha.)		2005 ECA Adjusted (ha.)	
			<H60	*>H60*	*Leader*	*Year*	*Height*	<H60	>H60	<H60	>H60	<H60	>H60	<H60	>H60	<H60	>H60
	6/669	1981	9.00			1991	0.80	9.00	0.00	6.75	0.00	6.75	0.00	6.75	0.00	6.75	0.00
	629	B		1.90		1991	7.00	0.00	0.19	0.00	0.19	0.00	0.19	0.00	0.19	0.00	0.19
	627	B		2.40			N	0.00	2.40	0.00	2.40	0.00	2.40	0.00	2.40	0.00	2.40
	15/723	1979	44.80			1989	0.40	44.80	0.00	33.60	0.00	33.60	0.00	33.60	0.00	33.60	0.00
	16/675	1980	40.40			1995	1.60	40.40	0.00	30.30	0.00	30.30	0.00	30.30	0.00	30.30	0.00
	13/707	1977	59.40			1989	0.90	44.55	0.00	44.55	0.00	44.55	0.00	44.55	0.00	44.55	0.00
	13/708	1977	14.60			1995	1.50	14.60	0.00	14.60	0.00	10.95	0.00	10.95	0.00	10.95	0.00
	766	B		6.70			N	0.00	6.70	0.00	6.70	0.00	6.70	0.00	6.70	0.00	6.70
	42/889			3.10			N	0.00	3.10	0.00	3.10	0.00	3.10	0.00	3.10	0.00	3.10
	14/768	1988	3.60	20.00		1990	0.20	3.60	20.00	3.60	20.00	3.60	20.00	2.70	15.00	2.70	15.00
	38/882		1.90			1996	0.30	1.90	0.00	1.90	0.00	1.90	0.00	1.90	0.00	1.90	0.00
	38/841		5.60			1996	0.30	5.60	0.00	5.60	0.00	5.60	0.00	5.60	0.00	5.60	0.00
	38/884	1995	10.15			1996	0.30	10.15	0.00	10.15	0.00	10.15	0.00	10.15	0.00	10.15	0.00
	11/704	1977	23.20			1992	2.00	17.40	0.00	17.40	0.00	17.40	0.00	17.40	0.00	17.40	0.00
	29/578		6.35	6.35		1990	0.20	6.35	6.35	6.35	6.35	6.35	6.35	4.76	4.76	4.76	4.76
	606	Logged	16.50			1991	6.00	4.13	0.00	4.13	0.00	4.13	0.00	4.13	0.00	4.13	0.00
	607	B49	58.70				N	58.70	0.00	58.70	0.00	58.70	0.00	58.70	0.00	58.70	0.00
	609	B49	12.00				N	12.00	0.00	12.00	0.00	12.00	0.00	12.00	0.00	12.00	0.00
	678	B49	41.60			1991	10.00	4.16	0.00	4.16	0.00	4.16	0.00	4.16	0.00	4.16	0.00
	524	B49	42.90			1991	10.00	4.29	0.00	4.29	0.00	4.29	0.00	4.29	0.00	4.29	0.00
	613	B49	14.20			1991	6.00	3.55	0.00	3.55	0.00	3.55	0.00	3.55	0.00	3.55	0.00
	695	Logged	2.50				N	2.50	0.00	2.50	0.00	2.50	0.00	2.50	0.00	2.50	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ROADS	length (km)		Area (ha)															
	<H60	>H60	<H60	>H60														
Main	13.6	1.6	27.20	3.20			road	27.20	3.20	27.20	3.20	27.20	3.20	27.20	3.20	27.20	3.20
Secondary	4		4.00	0.00			road	4.00	0.00	4.00	0.00	4.00	0.00	4.00	0.00	4.00	0.00
Other			0.00	0.00			road	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Included above in ECA calculations as clearings																		
Road		0.3																
Rail																		

	Area (ha)		
	Total	<H60	>H60
with roads	482.3	438.6	43.7
w/o roads	447.9	407.4	40.5

	2001 ECA		2002 ECA		2003 ECA		2004 ECA		2005 ECA	
	Adjusted	(ha.)	Adjusted	(ha.)	Adjusted	(ha.)	Adjusted	(ha.)	Adjusted	(ha.)
	<H60	>H60	<H60	>H60	<H60	>H60	<H60	>H60	<H60	>H60
ECAs(ha)	318.9	41.9	295.3	41.9	291.7	41.9	289.2	35.4	289.2	35.4
Total ECA(ha)	360.8		337.3		333.6		324.5		324.5	
Total ECA (%):	13.2		12.4		12.2		11.9		11.9	
ECA (%) >H60:		1.5		1.5		1.5		1.3		1.3
Total available ECA (ha)	184.7		208.3		211.9		221.0		221.0	
Roads										
ECAs(ha)	31.2	3.2	31.2	3.2	31.2	3.2	31.2	3.2	31.2	3.2
length (km)	17.6	1.9	17.6	1.9	17.6	1.9	17.6	1.9	17.6	1.9
density(km/km	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1
Total road density (km/km2)	0.7		0.7		0.7		0.7		0.7	

Roads

Total area (ha)	34.40
Total length (km)	19.5
Tot.density (km/km2)	0.71

Residual Area Sub-basin
2. ECA with Proposed Blocks

Company	CP/BLOCK	Year Logged	Area (ha) <H60	Area (ha) >H60				2001 ECA Adjusted (ha.) <H60	2001 >H60	2002 ECA Adjusted (ha.) <H60	2002 >H60	2003 ECA Adjusted (ha.) <H60	2003 >H60	2004 ECA Adjusted (ha.) <H60	2004 >H60	2005 ECA Adjusted (ha.) <H60	2005 >H60
Tolko	106-5	2006		16.60				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tolko	106-6	2006	2.90	20.50				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tolko	106-7	2006		17.60				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tolko	156-1	2006	26.00					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tolko	156-5	2006		31.50				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tolko	156-6	2006		12.20				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tolko	156-7	2006		20.60				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Roads			Area (ha)		Length (km)												
Secondary			<H60	>H60	Total	<H60	>H60										
		2005	0.00	9.30	9.30		9.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.30
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

With Proposed Blocks

Current plus up to the to the year 2005		Area (ha) Total	<H60	>H60		2001 ECA Adjusted (ha.) <H60	2001 >H60	2002 ECA Adjusted (ha.) <H60	2002 >H60	2003 ECA Adjusted (ha.) <H60	2003 >H60	2004 ECA Adjusted (ha.) <H60	2004 >H60	2005 ECA Adjusted (ha.) <H60	2005 >H60
	with roads	639.5	467.5	172.0	**ECAs (ha)**	318.9	41.9	295.3	41.9	291.7	41.9	289.2	35.4	289.2	44.7
	w/o roads	595.8	436.3	159.5	Total ECA (ha):	360.8		337.3		333.6		324.5		333.8	
					Total ECA (%):	13.2		12.4		12.2		11.9		12.2	
					ECA (%) >H60:		1.5		1.5		1.5		1.3		1.6
					Total available ECA (ha)	184.7		208.3		211.9		221.0		211.7	
					Roads										
					ECAs (ha)	31.2	3.2	31.2	3.2	31.2	3.2	31.2	3.2	31.2	12.5
					length (km)	17.6	1.9	17.6	1.9	17.6	1.9	17.6	1.9	17.6	11.2
					density(km/km	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.4
					Total road density (km/km2)	0.7		0.7		0.7		0.7		1.1	

Roads (Current plus up to the year 2005)

Total area (ha)	43.70
Total length (km)	28.80
Tot.density (km/km2)	1.06

ECA Summary table for Juliet Creek Watershed

Sub-basin	Area	Condition without development in 2001						Condition with proposed development									
		ECA**		Total	Roads			2001 ECA		2002 ECA		2003 ECA		2004 ECA		2005 ECA	
		Total	>H60	cleared				Total	>H60	Total	>H60	Total	>H60	Total	>H60	Total	>H60
		ha	ha	area	Area		Density	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha
	ha	%	%	ha	ha	%	km/km2	%	%	%	%	%	%	%	%	%	%
		Avail.ha		%				avail. ha.		avail. ha.		avail. ha.		avail. ha.		avail. ha.	
South Sub-basin		159.2	6.5	180.8	13.0	0.9	0.4	159.2	6.5	146.6	6.5	146.6	6.5	146.6	6.5	140.4	5.3
	1502.0	10.6	0.4					10.6	0.4	9.8	0.4	9.8	0.4	9.8	0.4	9.3	0.4
		141.2		12.0				141.2		153.8		153.8		153.8		160.0	
North Sub-basin		123.6	28.5	193.6	12.1	0.5	0.2	123.6	28.5	120.1	28.5	120.1	28.5	120.1	28.5	121.3	27.5
	2596.4	4.8	1.1					4.8	1.1	4.6	1.1	4.6	1.1	4.6	1.1	4.7	1.1
		395.7		7.5				395.7		399.2		399.2		399.2		398.0	
July Creek		258.1	113.6	280.8	21.4	1.0	0.6	258.1	113.6	251.6	107.2	251.6	107.2	249.0	104.7	260.8	116.5
	2090.1	12.3	5.4					12.3	5.4	12.0	5.1	12.0	5.1	11.9	5.0	12.5	5.6
		159.9		13.4				159.9		166.4		166.4		169.0		157.2	
Residual		360.8	41.9	482.3	34.4	1.3	0.7	360.8	41.9	337.3	41.9	333.6	41.9	324.5	35.4	333.8	44.7
	2727.7	13.2	1.5					13.2	1.5	12.4	1.5	12.2	1.5	11.9	1.3	12.2	1.6
		184.7		17.7				184.7		208.3		211.9		221.0		211.7	
Watershed Totals	8916.2	901.6	190.6	1137.4	80.9	0.9	0.6	901.6	190.6	855.6	184.1	851.9	184.1	840.2	175.1	856.3	193.9
		10.1	2.1					10.1	2.1	9.6	2.1	9.6	2.1	9.4	2.0	9.6	2.2
		881.6		12.8				881.6		927.7		931.3		943.0		926.9	

**The column ECA contains the ECA in hectares, as a percentage of the total area, and the hectares available up to the threshold.

Regen growth/year (m): 0.2 H60 elevation (m): 1500 Threshold ECA (%): 20

Road widths (m): Main: 20.0 Secondary: 10.0 Other: 5.0

ECA Summary table for Juliet Creek Watershed

Sub-basin	Area	Condition without development in 2002						Condition with proposed development									
		ECA**		Total	Roads			2002 ECA		2003 ECA		2004 ECA		2005 ECA		2006 ECA	
		Total	>H60	cleared				Total	>H60	Total	>H60	Total	>H60	Total	>H60	Total	>H60
		ha	ha	area	Area		Density	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha
	ha	%	%	ha	ha	%	km/km2	%	%	%	%	%	%	%	%	%	%
		Avail.ha		%				avail. ha.		avail. ha.		avail. ha.		avail. ha.		avail. ha.	
South Sub-basin		146.6	6.5	180.8	13.0	0.9	0.4	146.6	6.5	146.6	6.5	146.6	6.5	140.4	5.3	140.4	5.3
	1502.0	9.8	0.4					9.8	0.4	9.8	0.4	9.8	0.4	9.3	0.4	9.3	0.4
		153.8		12.0				153.8		153.8		153.8		160.0		160.0	
North Sub-basin		120.1	28.5	193.6	12.1	0.5	0.2	120.1	28.5	120.1	28.5	120.1	28.5	121.3	27.5	243.4	106.6
	2596.4	4.6	1.1					4.6	1.1	4.6	1.1	4.6	1.1	4.7	1.1	9.4	4.1
		399.2		7.5				399.2		399.2		399.2		398.0		275.9	
July Creek		251.6	107.2	280.8	21.4	1.0	0.6	251.6	107.2	251.6	107.2	249.0	104.7	260.8	116.5	260.8	116.5
	2090.1	12.0	5.1					12.0	5.1	12.0	5.1	11.9	5.0	12.5	5.6	12.5	5.6
		166.4		13.4				166.4		166.4		169.0		157.2		157.2	
Residual		337.3	41.9	482.3	34.4	1.3	0.7	337.3	41.9	333.6	41.9	324.5	35.4	333.8	44.7	477.1	163.7
	2727.7	12.4	1.5					12.4	1.5	12.2	1.5	11.9	1.3	12.2	1.6	17.5	6.0
		208.3		17.7				208.3		211.9		221.0		211.7		68.4	
Watershed Totals	8916.2	855.6	184.1	1137.4	80.9	0.9	0.6	855.6	184.1	851.9	184.1	840.2	175.1	856.3	193.9	1121.7	392.0
		9.6	2.1					9.6	2.1	9.6	2.1	9.4	2.0	9.6	2.2	12.6	4.4
		927.7		12.8				927.7		931.3		943.0		926.9		661.5	

**The column ECA contains the ECA in hectares, as a percentage of the total area, and the hectares available up to the threshold.

Regen growth/year (m): 0.2 H60 elevation (m): 1500 Threshold ECA (%): 20

Road widths (m): Main: 20.0 Secondary: 10.0 Other: 5.0

Photo 1: Juliet below confluence with July Creek. Note armoured banks upstream and downstream of Coquihalla highway.

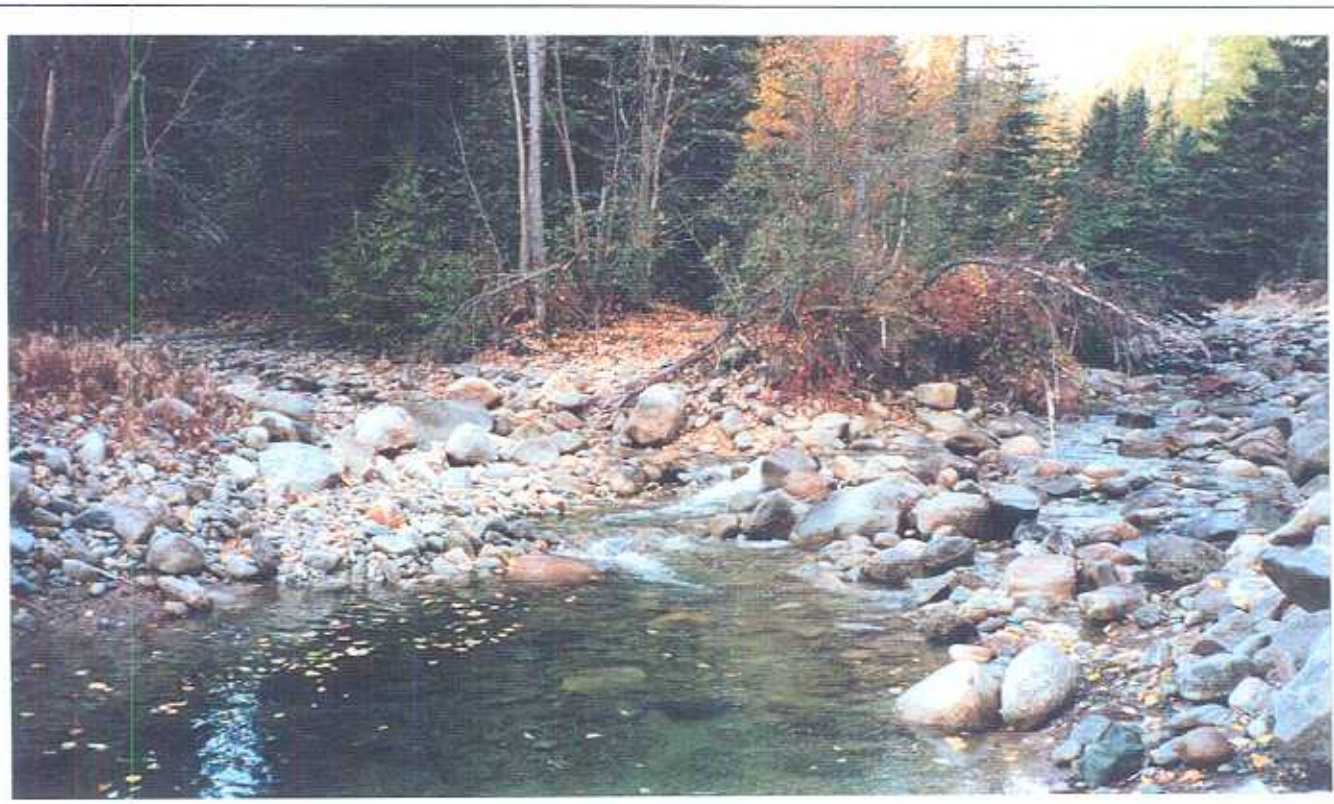


Photo 2: Confluence of July Creek (lft.) with Juliet Creek (rt.).

Photo 3: Juliet Creek just above July Creek. Generally aggraded bed, and eroding banks at right.

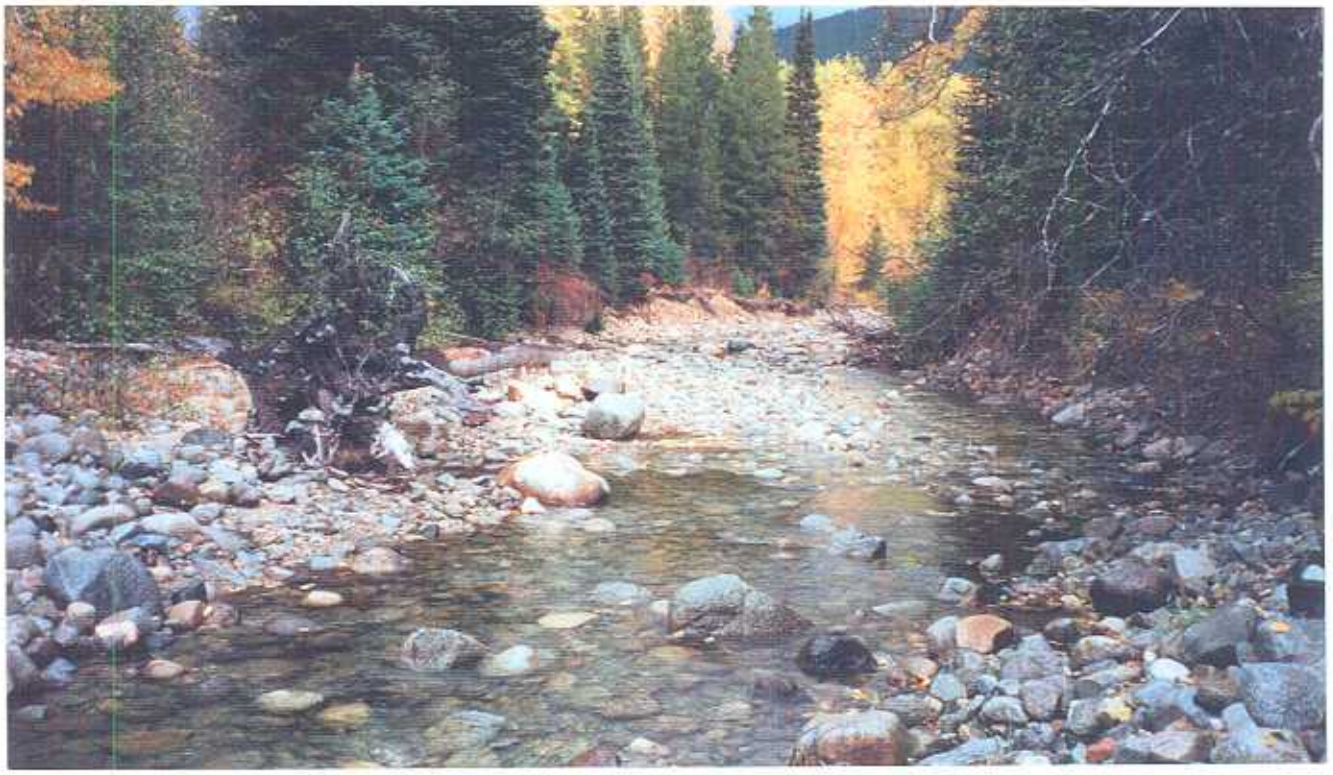


Photo 4: Juliet @ 101m. Note large boulder, lateral bars, and tree turned parallel to the channel.

Photo 5: Early colonization of lateral bar in Juliet mainstem @ CSS4.

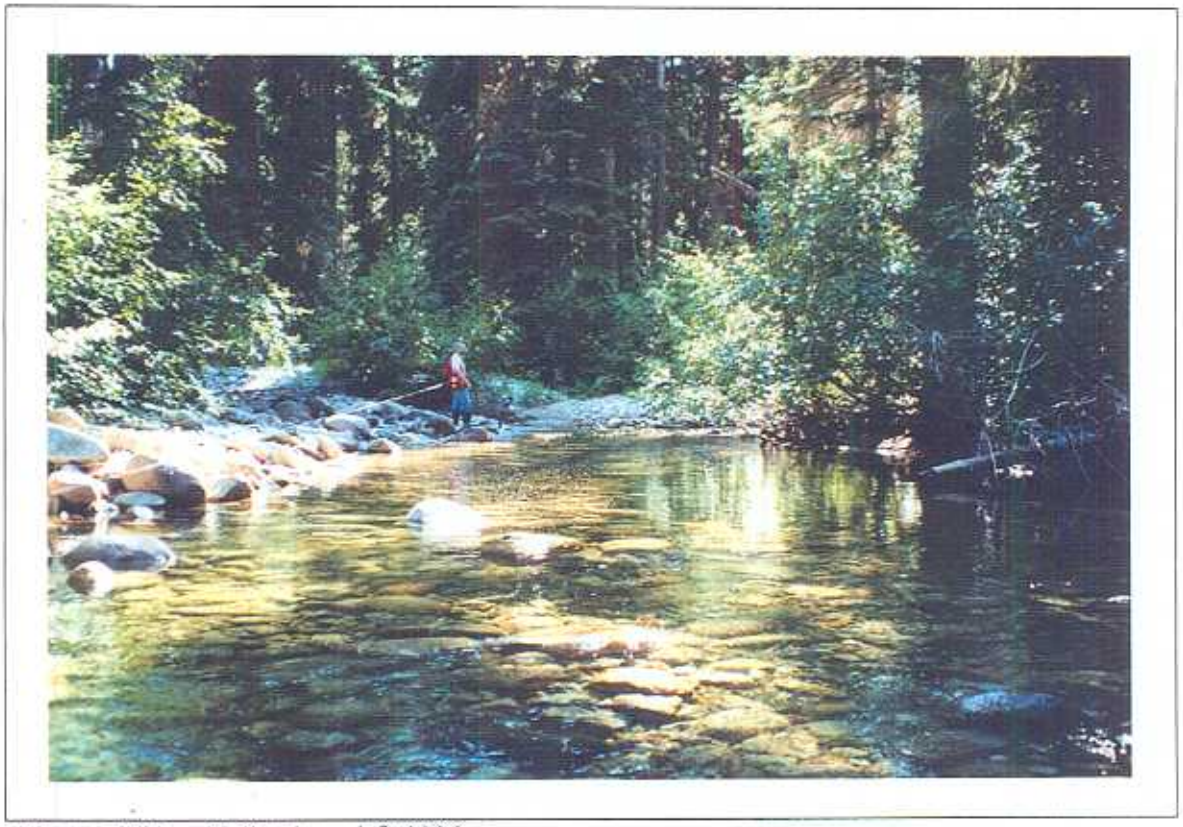


Photo 6: Widened Juliet channel @ CSS6.

Photo 7: Stable, bedrock and boulder controlled Juliet channel @ CSS1.

Photo 8: Old jam (rt.) at CSS3, Juliet.

Photo 9: Stable Juliet south @ 78m (CSS5).

Photo 10: Tributary 1, Residual area. Dry channel. Note boulder size, avulsion at right.

Photo 11: SS3 @ crossing at Tributary 1.

Photo 12: Juliet Tributary 4 @ mouth with Juliet (centre of photo).

Photo 13: Channel site 2, Juliet Creek. Note yellow rope, site of stream temperature monitoring.

Photo 14: July Creek @ 234m above mouth. Levee at channel edge deposited by debris flow.

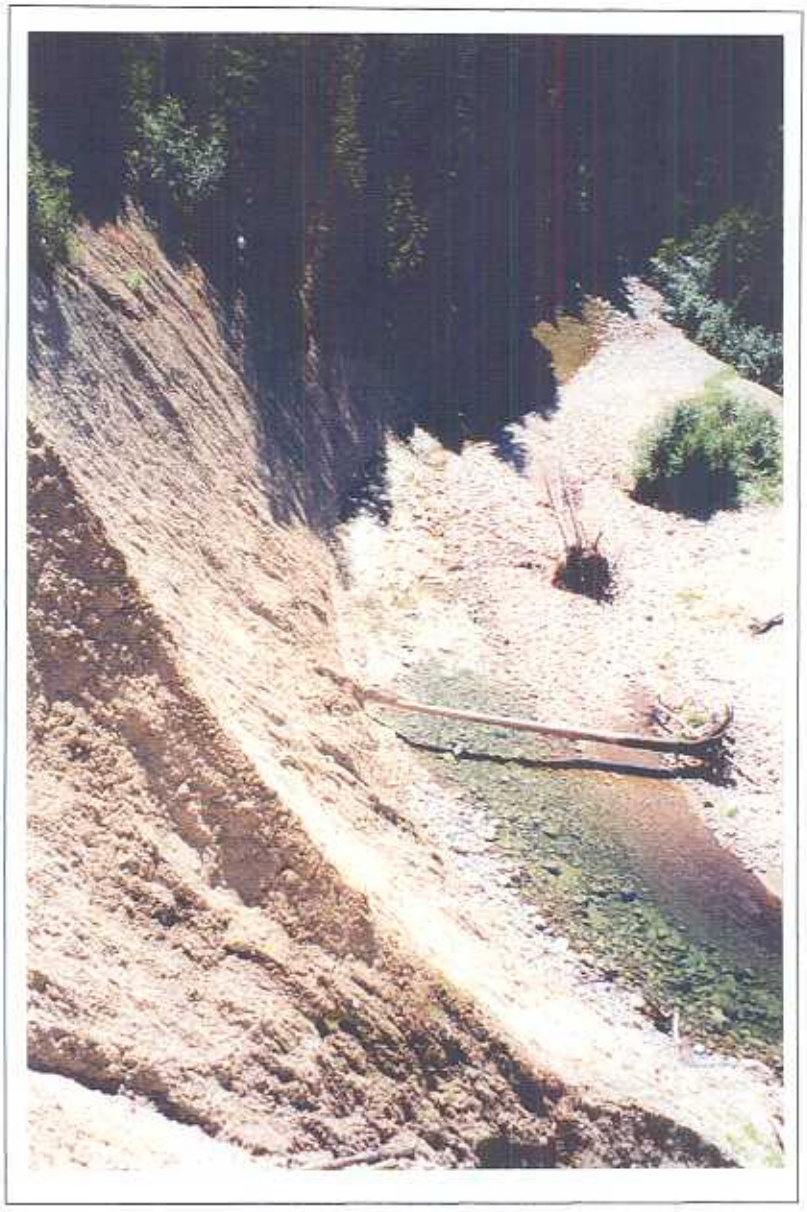


Photo 15: MW1, Juliet, prior to in-stream slope stabilization works.

Photo 16: MW1, with slope stabilization works in progress.

Photo 17: Stable road in Juliet Creek.

Photo 18: SS1. Flow diverted over road.

Photo 19: Culvert recommended at SS5 to prevent flow over road.

Photo 20: Collapsed structure in July Creek.

Photo 21: Full sediment silt fence at SS9.

Photo 22: Raveling at fillslope to culvert outlet, SS10.

Photo 23: Debris/torrent @ SS6.

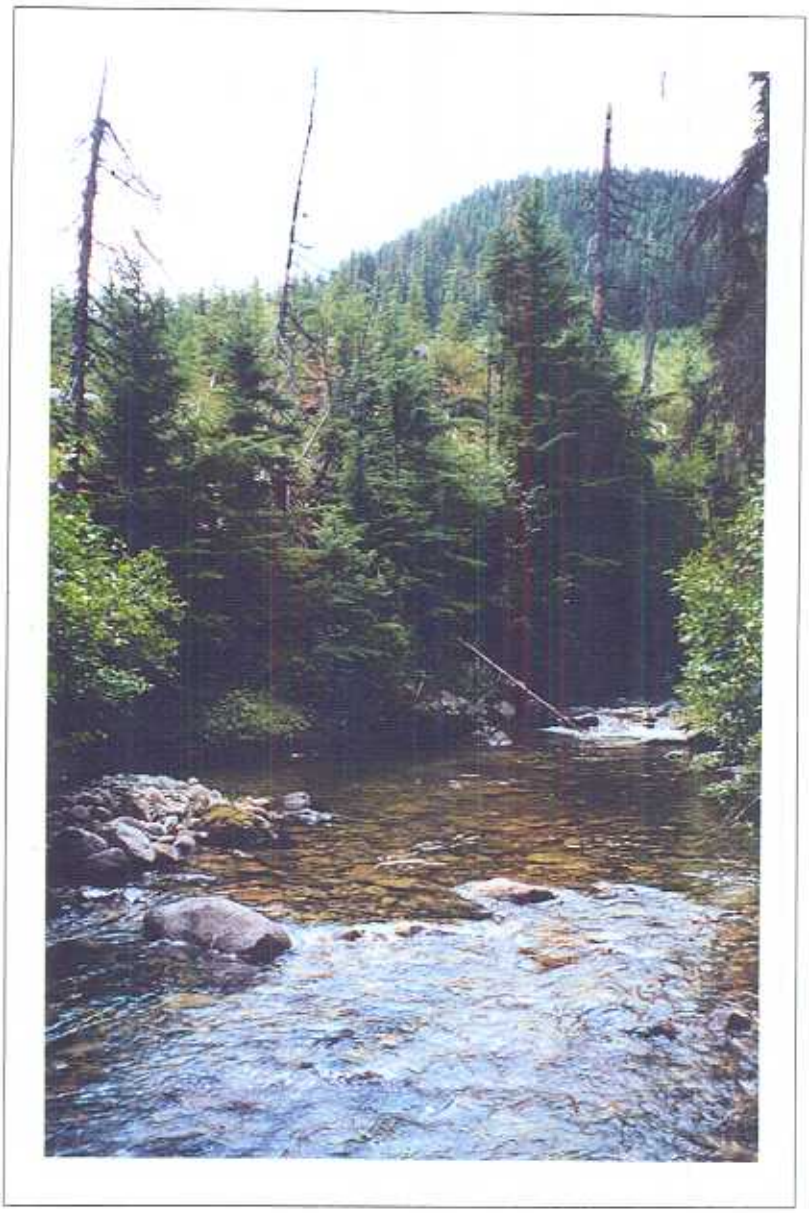


Photo 24: Near streambank logging @ RIP1.